Amendments

In the Specification:

At page 1 after the title of the invention, please insert the following paragraph:

a1 This application claims the benefit of U.S. Provisional Application Ser. No. 60/191,547, filed March 23, 2000, and U.S. Provisional Application Ser. No. 60/203,799, filed May 12, 2000, each of which is incorporated by reference herein in its entirety.

Please substitute the following paragraph [0030] for pending paragraph [0030]:

a2 FIG. 15 illustrates how to minimize cross-talk in a sensor array according to an embodiment of the invention.

Please substitute the following paragraph [0055] for pending paragraph [0055]:

a3 The present invention relates generally to a piezoelectric identification device and applications thereof. More particularly, it relates to a piezoelectric device for obtaining biometric data or information, such as a fingerprint, and using the obtained information to recognize and/or verify the identity of an individual.

Please substitute the following paragraph [0058] for pending paragraph [0058]:

a4 FIG. 2 illustrates the operating characteristics of a single rectangular piezo ceramic element 200 having surfaces 210, 220, 230, and 240. When force is applied to surfaces 210 and 220, a voltage proportional to the applied force is developed between surfaces 210 and 220. When this occurs, surfaces 230 and 240 move away from one another. When a voltage is applied to surfaces 210 and 220, surfaces 230 and 240 move towards one another, and surfaces 210 and 220 move away from one another. When an alternating voltage is applied

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to surfaces 210 and 220, piezo ceramic element 200 oscillates in a manner that would be known to a person skilled in the relevant art.

Please substitute the following paragraph [0060] for pending paragraph [0060]:

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FIG. 4 illustrates a two-dimensional array 400 of rectangular piezo ceramic elements 200. Array 400 can be made from lead zirconate titanate (PZT). PZT is an inexpensive material. In an embodiment, array 400 is similar to a PZT 1-3 composite used in medical applications. The piezo ceramic elements of sensor 110 according to the invention can have shapes other than rectangular. As illustrated in FIG. 5, sensor 110 can comprise an array 500 of circular piezo ceramic elements.

Please substitute the following paragraph [0061] for pending paragraph [0061]:

In a preferred embodiment, array 400 comprises rectangular piezo ceramic elements that are 40 microns square by 100 microns deep, thereby yielding a 20 MHz fundamental frequency sonic wave. A spacing of 10 microns is used between elements in this embodiment in order to provide a 50-micron pitch between elements. A pitch of 50-micron enables an identification device according to the invention to meet the Federal Bureau of Investigation's quality standards for fingerprints. Other embodiments of the invention use geometries different than the preferred embodiment. For example, a pitch of greater than 50 microns can be used. Other embodiments also operate a frequencies other than 20 MHz. For example, embodiments can operate at frequencies of 30 MHz and 40 MHz, in addition to other frequencies.

Please substitute the following paragraph [0062] for pending paragraph [0062]:

As shown in FIG. 6, the spacing between the elements of a sensor array according to the invention can be filled-in with a flexible type material or filler 602 to suppress any shear waves and give the sensor improved mechanical characteristics. Micro-spheres 604 can be

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added to the filler 602 (e.g., vinyl micro-spheres) to reduce weight and/or increase the suppression of shear waves. In order to optimize the signal-to-noise ratio of an identification device, and the device sensitivity, fillers (e.g., araldite filled with air filled vinyl micro-spheres) that provide high acoustical attenuating and electrical isolation should be used.

Please substitute the following paragraph [0065] for pending paragraph [0065]:

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FIG. 7B illustrates a sensor array 750 comprising piezoelectric film (piezo film) according to an embodiment of the invention. FIG. 7B is a cross-sectional view of sensor array 750. Sensor array 750 is a multi-layer structure that includes a piezoelectric layer 752 sandwiched by two conductor grids 754 and 756. Conductor grids 754 and 756 each consist of rows of parallel electrically conductive lines. Preferably, the lines of grid 754 are oriented orthogonal with respect to the lines of grid 756 (that is, in x and y directions, respectively). This orientation creates a plurality of individually addressable regions or elements in the piezo film. As used herein, the term element refers to any region of a sensor array that can be addressed, either individually or as part of a larger region, using the rows of parallel electrically conductive lines (conductors). Piezoelectric polymer film sensors are further described in *Piezo Film Sensors: Technical Manual*, available from Measurement Specialities, Inc. Norristown, PA, April 2, 1999 REVB (incorporated by reference herein in its entirety).

Please substitute the following paragraph [0073] for pending paragraph [0073]:

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The materials described herein for constructing sensor array 700 are illustrative and not intended to limit the present invention. Other materials can be used, as would be know<u>n</u> to a person skilled in the relevant art.

Please substitute the following paragraph [0082] for pending paragraph [0082]:

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In an embodiment, input signal generator 1202 comprises an input signal generator or oscillator 1204, an variable amplifier 1206, and a switch 1208. In a preferred embodiment, oscillator 1204 produces a 20 MHz signal, which is amplified to either a low or a high voltage (e.g., about 4 volts or 8 volts) by variable amplifier 1206, depending on the mode in which device 1200 is operating. Switch 1208 is used to provide either no input signal, a pulsed input signal, or a continuous wave input signal. Switch 1208 is controlled to produce the various types of input signals described herein in a manner that would be known to a person skilled in the relevant art. As shown in FIG. 12, the input signal generated by input signal generator 1202 is provided to sensor array 1220, through multiplexer 1225A, and to controller 1230 and output signal processor 1240.

Please substitute the following paragraph [0084] for pending paragraph [0084]:

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FIGs. 13A and 13B illustrate how to apply an input signal generated by input signal generator 1202 to the sensor array 1220, and how to receive an output signal from sensor array 1220 according to an embodiment of the invention. In a preferred embodiment, sensor array 1220 comprises 200,000 elements 200 arranged in a two-dimensional array (i.e., a 500 x 400 element array). The 500 conductors of array 1220 that connect, for example, to the element rows on the bottom of array 1220 must be connected to input signal generator 1202, either one at a time or in various groupings, while the 400 lines that connect to the columns on the top of the array 1220 must be connected, for example, to an impedance meter or Doppler circuit, either one at a time or in various groups. This task is accomplished by multiplexers 1225.

Please substitute the following paragraph [0086] for pending paragraph [0086]:

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In an embodiment, multiplexers 1225 comprise seventeen 16:1 multiplexers, thus giving one output or 16 outputs as selected. The function of each switch in the multiplexer

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is determined by a shift register 1302 that is 272 bits long and 2 bits wide (see FIG. 13B). The loading and clocking of shift register 1302 is performed by controller 1230, which comprises a counter and logic that would be known to a person skilled in the relevant art. As shown in FIG. 13A, the conductors of sensor array 1220 can be connected to either ground, signal input generator 1202, or they can be unconnected (high impedance). Multiplexer 1225A is designed for lowest "on" resistance. Multiplexer 1225B connects all (256) conductors of one side of sensor array 1220 to one or sixteen sense nodes. Both multiplexers 1225A and 1225B are connected to the same function logic (i.e, controller 1230) so that the proper sensor elements are selected and used, for example, for voltage sensing. Element columns and rows, in the neighborhood of an element or group of elements selected for sensing, can be switched to ground to prevent coupling and interference.

Please substitute the following paragraph [0087] for pending paragraph [0087]:

FIG. 13B illustrates how to control the switches of multiplexers 1225 according to an embodiment of the invention. As described herein, each switch of multiplexer 1225 connected to a conductor of array 1220 can be in one of three states: connected to ground, connected to signal input generator 1202, or open (high impedance). This can be implemented, for example, using two CMOS gates, as shown in FIG. 14. A 272 bit long by 2 bit wide shift register can then be used to control the position of each switch. Bits from controller 1230 are shifted into shift register 1302 to control the position of the switches of multiplexers 1225. In an embodiment, shift register 1302 is coupled to the switches of multiplexer 1225 using latches so that the position of the multiplexer switches remain constant as new bits are being shifted into shift register 1302. How to implement this embodiment would be known to a person skilled in the relevant art. Other means for implementing the functionality of multiplexers 1225 can be used without departing from the scope of the invention.

Please substitute the following paragraph [0092] for pending paragraph [0092]:

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FIG. 15 illustrates means for increasing scanning speed and minimizing cross-talk in a sensor array 1500 according to an embodiment of the invention. As seen in FIG. 15, multiple elements can be active simultaneously and a first means for minimizing cross-talk is to separate geographically the active elements 1502 of array 1500. As explained herein, a dynamic grounding scheme (i.e., coupling the elements 1504 in the neighborhood of an active element 1502 to ground) can be used that moves with the active elements 1502 as they scan across the sensor array 1500. This reduces the capacitive coupling to ground and electrical cross-talk while maintaining a Faraday Cage for all sensed frequencies. In addition, an interstitial filler can be used to reduce cross-talk and thereby the parasitic currents in the neighborhood of the selected elements 1502. Other elements of array 1500, e.g., elements 1506, are connected to conductors that are open.

Please substitute the following paragraph [0104] for pending paragraph [0104]:

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When operating in the impedance mode, identification device 1200 determines the absolute impedance of an element 200 and/or the change in impedance of an element 200 with frequency to determine whether a given element 200 is loaded by a fingerprint ridge 1704 or a fingerprint valley (cavity) 1706. To obtain a measure of the impedance of an element 200, input signal generator 1202 is used to produce low voltage pulses that are input to the elements of sensor array 1220 using multiplexer 1225A. The output signals obtained at multiplexer 1225B are related to the absolute impedance of the elements 200 of array 1220. These output signals are routed by switch 1250 to impedance detector 1242 to determine a measure of the absolute impedances of the elements of array 1220. To obtain a fingerprint, it is only necessary that impedance detector 1242 be able to determine whether a given element 200 is loaded by a fingerprint ridge or a fingerprint valley. These determinations of whether a particular element 200 is loaded by a fingerprint ridge or fingerprint valley can be used to generate pixel data that represents the fingerprint of finger

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1702. The fingerprint is stored in memory 1270. The fingerprint can also be transmitter to other devices as described below.

Please substitute the following paragraph [0113] for pending paragraph [0113]:

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To obtain a map of bone 2402, a high voltage, pulsed input signal is generated by input signal generator 1202 and provided to the elements of array 1220. This input signal causes the elements to generate sonic waves that travel into finger 1702. As shown in FIG. 24, only certain elements 200 of array 1220 are actively generating sonic waves at any given time. In accordance with the invention, and as described herein, active sonic wave transmitting and receiving apertures are configured and moved (scanned) across sensor array 1220 using controller 1230 and multiplexers 1225. The generated sonic waves travel through finger 1702 and are reflected by the structure of bone 2402. These reflected sonic waves are then detected by the receiving apertures. The time of travel of the sonic waves are obtained by detector 1246 of device 1200 and used to detect whether bone structure is located at a various distances from array 1220. As would be known to a person skilled in the relevant art, this mode of operation is similar to how radars operate.

Please substitute the following paragraph [0121] for pending paragraph [0121]:

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FIG. 31 is a flowchart of a more detailed method 3100 for obtaining biometric data using device 1200. Method 3100 is described with reference to a particular embodiment of device 1200 having a piezo film sensor array.

Please substitute the following paragraph [0122] for pending paragraph [0122]:

In step 3102, device 1200 is awakened and piezo film sensor array 1220 is switched to detect an initial pixel or a group of pixels. Controller 1230 switches multiplexers 1225A and 1225B to a designated initial pixel or group of pixels. In one example, piezo film sensor array 1220 is a 512x512 pixel array. Multiplexers 1225A and 1225B are each used to

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addressed and/or select a particular grid line (conductor) at a designated address of the initial pixel or group of pixels being detected.

Please substitute the following paragraph [0128] for pending paragraph [0128]:

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As described above, piezo film sensor array 1220 can be switched by multiplexers 1225A and 1225B to detect voltage values at a single pixel or a group of pixels. In general, any pattern for scanning pixels can be used. For example, a raster scan of pixels can be performed. Pixels can be scanned row by row or column by column.

Please substitute the following paragraph [0130] for pending paragraph [0130]:

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FIG. 32 illustrates a biometric device 3202 according to an embodiment of the invention. Device 3202 has a sensor array 3204 according to the invention. Device 3202 is particularly adapted for obtaining and storing fingerprint data according to the invention. Device 3202 is intended, for example, to be used by law enforcement personnel.

Please substitute the following paragraph [0132] for pending paragraph [0132]:

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FIG. 34 illustrates a wireless transceiver biometric device 3400 according to an embodiment of the invention. Device 3400 is intended to be used by the general populace, for example, as an electronic signature device. Device 3400 has a sensor 3402 for obtaining biometric data, such as a fingerprint, according to the invention. Device 3400 also is shown as having three indicator lights 3404 for communication information to a user.

Please substitute the following paragraph [0133] for pending paragraph [0133]:

FIG. 35 illustrates a more detailed view of the wireless transceiver biometric device 3400. As can be seen in FIG. 35, sensor 3402 is powered by a battery 3504. Device 3400 has an antenna 3502 that can be used for sending information to and receiving information from

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other devices. Device 3400 can be made to be compatible with BLUETOOTH wireless technology. A key ring 3506 can be attached to device 3400. As illustrated by FIGs. 36 and 37, device 3400 has a multitude of possible uses.

Please substitute the following paragraph [0134] for pending paragraph [0134]:

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FIG. 36 illustrates using the wireless transceiver biometric device 3400 to complete an electronic sales transaction. In step 1 of the transaction, device 3400 is used to obtain a fingerprint of the individual wanting to make a purchase. Device 3400 then transmits the fingerprint to a device coupled to cash register 3602 (step 2), which sends the fingerprint to a third party verification service 3604 (step 3). The third party verification service uses the received fingerprint to verify the identity of the purchaser (step 4) by matching the received fingerprint to fingerprint data stored in a database. The identity of the purchaser can then be sent to cash register 3602 (step 5) and to a credit card service 3606 (step 6). The credit card service uses the data from the third party verification service to approve sales information received from cash register 3602 (step 7) and to prevent the unauthorized use of a credit card. Once cash register 3602 receive verification of the purchaser's identity and verification that the purchaser is authorized to use the credit card service, cash register 3602 can notify device 3400 to send a credit card number (step 8). Cash register 3602 can then send the credit card number to the credit card service 3606 (step 9), which then transfers money to the sellers bank account (step 10) to complete the sales transactions. These steps are illustrative of how device 3400 can be used as an electronic signature device, and are not intended to limit the present invention.